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1979 SOLAR ÉCLIPSE
PART I
ATMOSPHERIC SCIENCES LABORATORY FIELD PROGRAM SUMMARY

MAY 1980

By

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The 26 February 1979 solar eclipse provided a unique opportunity to investigate the properties of the middle atmosphere, including the lower ionospheric D region, during a succinct day-"night"-day transition. The Atmospheric Sciences Laboratory (ASL) assisted in coordinating a multiagency field experiment program which encompassed a wide range of effort. Experiments carried out during the several-day period centering on the eclipse were characterized by an unusually high degree of success. Nineteen small sounding rockets and → over

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ABSTRACT (cont)

14 large rockets were launched without a major experimental failure. Ground-based measurements provided additional information. Of particular interest to the Army is the investigation of electron attachment/detachment processes in the D region which in turn have a bearing on ELF, VLF, and HF communications, BMD radar systems, and atmospheric deionization in the post-nuclear-burst atmosphere. This report is Part I of a series and is primarily concerned with providing a summary of the 1979 Solar Eclipse Field Program and sponsored experiments. Part II will provide an account of the experimental data acquired by the ASL experiments, and a subsequent Part III will detail the atmospheric modeling efforts using the data from the 1979 solar eclipse.

ACKNOWLEDGMENTS

Much of the background material which has gone into this report and much of the initial preparation for the 1979 Solar Eclipse Field Program have been performed for the Atmospheric Sciences Laboratory by the Physical Science Laboratory, New Mexico State University, under contract DAAD07-78-C-0058. The success of any large field program depends on the cooperation and effort of a great many people. The authors especially thank the Atmospheric Sciences Laboratory launch crews and the Physical Science Laboratory support personnel and also express appreciation for the cooperation extended by the National Research Council of Canada, the National Aeronautics and Space Administration, and the Air Force Geophysics Laboratory.

CONTENTS

INTRODUCTION

The total solar eclipse of 26 February 1979 passed over the North American Continent on a path which crossed the states of Oregon, Washington, Idaho, and Montana and the Canadian provinces of Manitoba and Ontario. This eclipse was the last total solar eclipse which could be observed from North America this century and presented the opportunity to mount a coordinated field program without formidable logistical cost.

The US Army Atmospheric Sciences Laboratory (ASL) assisted in coordinating the 1979 Solar Eclipse Field Program in conjunction with the National Aeronautics and Space Administration (NASA), the Air Force Geophysics Laboratory (AFGL), and the National Research Council of Canada (NRC). Rarely has such a degree of success been attained as was reached by this program. Of approximately 80 separate measurements made involving 33 sounding rockets, only 2 yielded substantially less data than planned. Subsequent analyses will yield complementary sets of data from what may well prove to be the best set of coordinated middle atmospheric measurements of the seventies decade.

One major objective of the Solar Eclipse Program is to obtain sets of complementary measurements in the D region of the lower ionosphere (60 to 90 km) which can be compared with simulated data from appropriate atmospheric modeling codes, thus either validating the models or suggesting new processes which should be included. The need for the current sets of measurements and the implications of past measurements on Army communications and defense systems have been detailed in previous reports.[1-3]

The absence of existing sounding rocket installations and ranges along the eclipse path posed rather severe constraints on the site location. The combination of safety requirements, the equally restrictive logistical problems, and the eclipse totality requirements for rocket

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[1]M. G. Heaps, R. O. Olsen, and W. W. Berning, 1972, Solar Eclipse 1979: Atmospheric Sciences Laboratory Program Overview, ASL-TR-0026, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[2]M. G. Heaps, 1978, The 1979 Solar Eclipse and Validation of D-Region Models, ASL-TR-0002, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

[3]M. G. Heaps, F. E. Niles, and R. D. Sears, 1978, Modeling the Ion Chemistry of the D-Region: A Case Study Based on the 1966 Total Solar Eclipse, ASL-TR-0015, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM

measurements left only a few potential sites for rocket operation. In cooperation with the NRC and the NASA/WFC, these potential sites were surveyed with final site selection settling on the Red Lake area in western Ontario, Canada (91°45' W, 51° N).

In developing a research program for the solar eclipse, principal Army interest centered on the behavior of the ionosphere and neutral atmosphere below 100 km. Under quiet conditions, solar photon radiation is the major source of ionization above 70 km with galactic cosmic rays providing a smaller (but dominant) source below 70 km. Under disturbed conditions--such as actually occurred during the eclipse period--precipitation of energetic electrons proved to be the largest source of ionization. Experiments designed to measure in situ the several ionizing sources, electron density and densities of several important neutral species were flown on the larger sounding rockets. (These experiments, along with those designed by the AFGL and NASA, constitute what is often called "the large rocket program.") Another goal of the research program was to measure numerous atmospheric parameters during the week leading up to, through, and after the eclipse, thus providing a data background during this period. The various payloads were flown with the smaller meteorological rockets. (These experiments are often called "the small rocket program.") In addition to the in situ measurements, a partial reflection sounder was operated during the entire period to provide near-continuous profiles of electron densities in the D region.

BACKGROUND FIELD PROGRAM INFORMATION

Site Locations

The Solar Eclipse Program was conducted from two general locations with three specific sites at each location. Figure 1 shows the Red Lake area. The ASL sponsored small rocket program was conducted from the small rocket launch site at the McMarmac Mine site just north of the town of Cochenour. The small rocket instrumentation site--including storage, assembly, and tracking facilities--was located on the property of the Cochenour-Willans Mine about 2 km from the launch site. These sites were shared with the National Research Council of Canada. In addition, a building at the Cochenour-Willans Mine served as the command post for the entire program. Finally, the partial reflection sounder was located in Balmertown, about 6 km from the small rocket sites.

The large rocket program, which was run in conjunction with AFGL and NASA, was conducted from a location approximately 30 km southeast of the small rocket sites. The large rocket launch site was separated from the instrumentation site by about 6 km on an east-west line across the Chukuni River. The large rocket storage and assembly site was located in a building at the Griffith Mine about 10 km from the launch site.

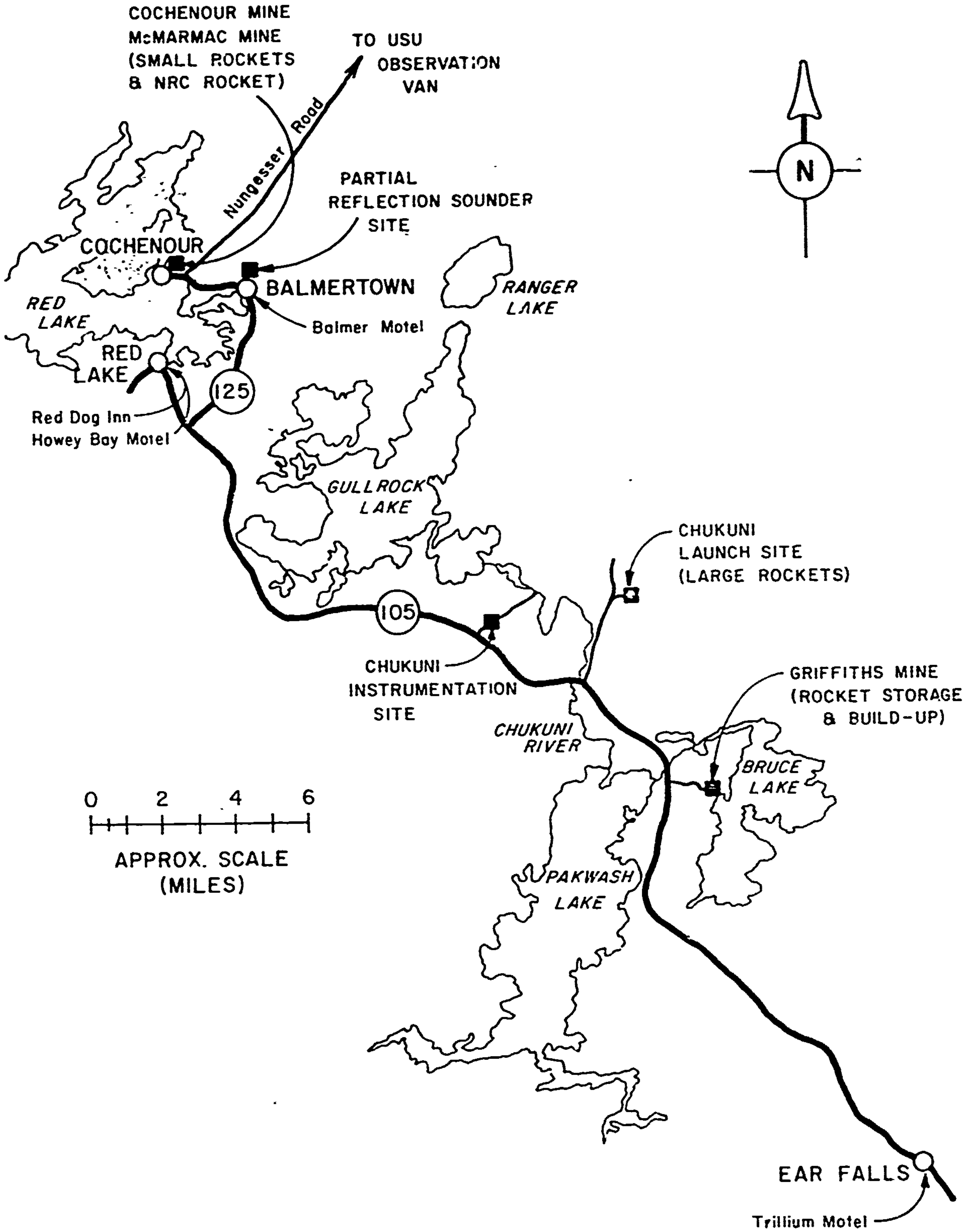

Figure 1. Solar eclipse of 1979 support areas in Red Lake, Ontario, Canada.

Rocket Designations

A total of 19 of the smaller meteorological rockets were flown under the ASL sponsored small rocket program; their designations are as follows:

Rocket Type	Designation	Number
Super Loki/Dart	CMSL-01-79 through CMSL-10-79	9*
Super Arcas	CMSA-01-79 through CMSA-10-79	10

*CMSL 07 was not flown

Additionally, one Black Brant V was flown by NRC from the small rocket site.

Fourteen larger sounding rockets were flown from the large rocket site, two of which carried ASL sponsored payloads.

Rocket Type	Designation	Number
Nike Orion	ASL-SE-79A1	2
	ASL-SE-79B1	

In addition, four AFGL rockets used the ASL dual beam launchers, and eight NASA sponsored rockets were also launched.

OVERVIEW OF LAUNCH SCHEDULE AND TYPES OF DATA AVAILABLE

Many measurements were made at frequent intervals over a period of several days preceding and on the day following the solar eclipse itself (Monday, 26 February 1979). Rocket launches were conducted 19 to 27 February, with coordinated measurements occurring on the 24th, 26th, and 27th. The purpose was to take additional sets of data which could be used as bases of comparison with the larger body of data from the day of the eclipse. Tables 1 and 2 give quick summaries of the launch schedules and types of measurements made. Table 3 organizes the data according to classes and lists the actual measurements made as well as supporting data available from other sources.

TABLE 1. OVERVIEW OF ROCKET LAUNCH SCHEDULE

February 1979

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
18	19 ASL-S	20 N*	21	22	23 ASL-S	24 ASL-S-3x
25 ASL-S-3x	26 ASL-S-7x ASL-L-2x AF-4x N-5x C	27 ASL-S-4x N	28			

ASL-S - ASL sponsored small rocket
ASL-L - ASL large rocket
AF - Air Force rocket
N - NASA rocket
C - NRC rocket
x - number of rockets
* - NASA launch coordinated with noneclipse related satellite fly-by

TABLE 2. 1979 SOLAR ECLIPSE SOUNDING ROCKET LAUNCH SUMMARY

Launch Date	Vehicle Identification	Launch Time (UT)	Predicted Apogee (km)	Predicted Flt Time (sec)	Measured Parameters
19 February	CMSL-01	2023	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
23 February	CMSL-02	1759:58	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
24 February	CMSL-03	1551	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
24 February	18.1020 UE	1652	137	870	• Positive Ion Composition and Rel Density; • Electron Density/Temperature; • Electron/Proton Flux; • Solar X-Rays; • Solar Lyman Alpha (Lα)
24 February	CMSA-01	1654:50	92	360	• Electron Density; • Solar Lyman Alpha Radiation (Lα)
24 February	CMSA-10	1722	66	7200	• Positive and Negative Ion Conductivities
25 February	CMSA-02	1700:03	92	360	• Electron Density; • Solar Lα
25 February	CMSA-05	1730	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
25 February	CMSL-04	1830	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
26 February	ASL-SE-79A1 (A1)	1628	133	354	• Density and Altitude Distribution of NO, O, O_3, OH and O_2 ($^1\Delta g$); • Solar Lα; • Electron Density and Temperature
26 February	ASL-SE-79B1 (B1)	1628:30	150	374	• Solar Lα; • Electron/Proton Flux and Spectra; Solar X-Rays; • Cosmic Ray Flux (>2 Mev), • Solar UV (2050 Å); • Electron Density/Temperature; • Atmospheric Density/Temperature (40-150 km)
26 February	AMF-VA-51	1650:45	135	700	• Vacuum UV Spectra of Prominences and Corona/Chromosphere Interface; • Electron Density/Temperature; • Altitude Distribution of O_3
26 February	23.010 UE	1650:50	82	6300	• Positive and Negative Charge Conductivity (w/wo Flashing Lamps); • Vertical Electric Field
26 February	A12.942 (G1)	1651:55	133	354	• Atmospheric Infrared Emission of OH (2.7μ), O_3 (9.6μ) and Excited O_3 or CO_2 (10.4μ)
26 February	18.1021 UE	1652	137	870	• Positive Ion Composition and Rel Density; • Electron Density/Temperature; • Electron/Proton Flux; • Solar X-Rays; • Direct/Scattered Solar Lα
26 February	A10.802-1 (C1)	1652:30	120	700	• Positive and Negative Ion Composition and Relative Densities; • Total Positive and Negative Ion Densities
26 February	CMSA-06	1653	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
26 February	33.304 UE	1653:30	194	700	• AC/DC Vector Electric Fields; • Plasma Wave Amplitude/Spectra; • Electron Density/Temperature; • Positive Ion Composition
26 February	33.303 UE	1653:45	184	700	• Neutral and Positive Ion Composition; • Electron, Ion Density/Temperature; • Visible and UV Airglow (Selected Wavelengths)
26 February	18.1022 UE	1654:10	137	870	• Negative Ion Composition and Rel Density; • Electron Density/Temperature; • Electron/Proton Flux; • Solar X-Rays; • Direct/Scattered Solar Lα
26 February	CMSA-07	1738	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
26 February	A10.802-2 (C2)	1741	120	700	• Positive and Negative Ion Composition and Relative Densities; • Total Positive and Negative Ion Densities
26 February	A07.712-2 (B2)	1748	200	560	• Atmospheric Density and Temperature (30-105 km)
26 February	CMSA-03	1840	92	360	• Electron Density; • Solar Lα
26 February	CMSL-05	1915	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
27 February	CMSA-08	0300	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
27 February	CMSL-09	1440	66	7200	• Positive and Negative Ion Conductivities
27 February	CMSL-06	1530	66	7200	• Atmospheric Temperature; • Winds, (10-60 km)
27 February	23.009 UE	1200	82	6300	• Positive and Negative Charge Conductivity (w/wo Flashing Lamps), • Vertical Electric Field
27 February	CMSA-09	[illegible]	77	6000	• Positive and Negative Ion Conductivity, Mobility and Density
27 February	CMSA-04	1410	92	360	• Electron Density; • Solar Lα
27 February	CMSL-10	1440	66	7200	• Positive and Negative Ion Conductivities
27 February	CMSL-08	1515	66	7200	• Atmospheric Temperature; • Winds (10-60 km)

TABLE 3. SOURCES OF DATA RELEVANT TO THE 1979 SOLAR ECLIPSE MEASUREMENTS NEAR RED LAKE

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Electron density	Rocket 18.1020 UE	2/24	1652	Profile, 65-135 km
	Rocket CMSA-01	2/24	1654:50	Profile, 60-90 km
	Rocket CMSA-02	2/25	1700:03	Profile, 60-90 km
	Rocket ASL-A1	2/26	1628	Profile, 65-135 km
	Rocket ASL-B1	2/26	1628:30	Profile, 65-155 km
	Rocket AMF-VA-51	2/26	1650:45	Profile, 65-130 km
	Rocket 18.1021 UE	2/26	1652	Profile, 65-135 km
	Rocket 33.004 UE	2/26	1653:30	Profile, 80-195 km
	Rocket 33.003 UE	2/26	1653:45	Profile, 80-185 km
	Rocket 18.1022 UE	2/26	1654:10	Profile, 65-135 km
	Rocket CMSA-03	2/26	1840	Profile, 60-90 km
	Rocket CMSA-04	2/27	1410	Profile, 60-90 km
	Polarimeter	2/15-2/27	Continuous except for infrequent power loss and maintenance	Provides measure of total electron content between Chukuni launch site and satellite ATS-3
	Partial reflection sounder	2/8-2/27	Intermittent but 1-minute intervals at time of eclipse	Profile, 60-100 km
	Ionosonde	2/16-2/26	Intermittent but 30-second intervals (Kenora) at time of eclipse	Profile of E- and F-regions Ionsondes at Kenona (Ont.) Ottawa (Ont.), Churchill (Man.), and Saskatoon (Sask.)
Ion composition and relative densities	Rocket 18.1020 UE	2/24	1652	Positive ions, 65-135 km
	Rocket 18.1021 UE	2/26	1652	Positive ions, 65-135 km
	Rocket A10.802-1	2/26	1652:30	Positive and negative ions, 65-117 km
	Rocket 33.004 UE	2/26	1653:30	Positive ions, 100-195 km
	Rocket 33.003 UE	2/26	1653:45	Positive ions, 100-185 km
	Rocket 18.1022 UE	2/26	1654:10	Negative ions, 65-135 km
	Rocket A10.802-2	2/26	1741	Positive and negative ions, 65-117 km
Atmospheric emission	Rocket ASL-A1	2/26	1628	Infrared at 1.27μm, 1.595μm, 1.944μm
	Rocket AMF-VA-51	2/26	1650:45	2150 Å Infrared at 1.27μm
	Rocket A12.9A2	2/26	1651:55	Infrared at 2.9μm, 9.6μm, and 10.4μm
	Rocket 33.003 UE	2/26	1653:45	UV at 1100-1600 Å Visible at 3466 Å and 5199 Å

*Times are given in UT (subtract 6 hours from local time). Times for sounding rockets represent time of launch.

TABLE 3 (continued)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Atmospheric emission	Mobile optical observatory	2/24-2/26	Evening twilight and totality	Infrared spectrometer, 1-3μm
				Radiometers at 1.27μm and 2.7μm
Densities of minor neutral species	Rocket ASL-A1	2/26	1628	Profiles of O, OH, O_3 and $O_2(^1\Delta g)$, 65-135 km
	Rocket AMF-VA-51	2/26	1650:45	Profiles of O_3, 65-130 km
	Satellite (NIMBUS G)	2/26	Sun synchronous polar orbit	Profiles, into lower mesosphere NO_2, H_2O, O_3, HNO_3 and CO_2
				Profiles to altitude of 65 km (max), of H_2O, N_2O, CH_4, CO and NO
				Total O_3 content
	Satellite (DMSP)	2/26	Early morning and local noon	Profiles through stratosphere H_2O and O_3
	Satellite (TIROS N)	2/26	Sun synchronous	Profile of H_2O to ~ 50 km
Positive/negative ion conductivity, mobility and density	Rocket CMSA-10	2/24	1722	Conductivities, 30-85 km
	Rocket CMSA-05	2/25	1730	Profile, 30-77 km
	Rocket 23.010 UE	2/26	1650:50	Profile, 45-85 km
	Rocket CMSA-06	2/26	1653	Profile, 30-55 km
	Rocket CMSA-07	2/26	1738	Profile, 30-77 km
	Rocket CMSA-08	2/27	0330	Profile, 30-77 km
	Rocket CMSL-09	2/27	0440	Conductivities, 30-65 km
	Rocket 23.009 UE	2/27	1200	Profile, 30-85 km
	Rocket CMSA-09	2/27	1306	Profile, 30-77 km
	Rocket CMSL-10	2/27	1440	Conductivities, 30-65 km
Direct and scattered solar ultraviolet	Rocket 18.1020 UE	2/24	1652	1216 Å
	Rocket CMSA-01	2/24	1654:50	1216 Å
	Rocket CMSA-02	2/25	1700:03	1216 Å
	Rocket ASL-A1	2/26	1628	1216 Å
	Rocket ASL-B1	2/26	1628:30	1216 Å, 2050 Å
	Rocket 18.1020 UE	2/26	1652	1216 Å
	Rocket 18.1022 UE	2/26	1654:10	1216 Å
	Rocket CMSA-03	2/26	1840	1216 Å
	Rocket CMSA-04	2/27	1410	1216 Å
	Satellite (AE-E)	2/24, 2/26	One orbit	140 Å - 1190 Å, 1227 Å - 1850 Å
	Satellite (NIMBUS G)	2/26	Sun synchronous	0.2-5μm (9-channels)
Particle precipitation	Rocket 18.1020 UE	2/24	1652	Electrons/protons > 10 kev
	Rocket ASL-A1	2/26	1628:30	Electrons/protons > 10 kev

*Times are given in UT (subtract 6 hours from local time). Times for sounding rockets represent time of launch.

TABLE 3 (CONT)

Data Element	Source of Measurement	Date	Time of Measurement*	Comments
Particle precipitation	Rocket 18.1021 UE	2/26	1652	Electrons/protons > 10 kev
	Rocket 18.1022 UE	2/26	1654:10	Electrons/protons > 10 kev
	Satellite (TIROS N)	2/26	1315-2015	Electrons > 0.3 kev Protons > 30 kev
	Satellite (P-78-1)	2/26	Sun synchronous	Electrons 3 < E < 1000 kev Protons 100 < E < 10^5 kev
Atmospheric density and temperature	Rocket CMSL-01	2/19	2023	Temperatures, 30-65 km
	Rocket CMSL-02	2/23	1759:58	Temperatures/winds, 30-65 km
	Rocket CMSL-03	2/24	1551	Temperatures/winds, 30-65 km
	Rocket CMSL-04	2/25	1830	Temperatures/winds, 30-65 km
	Rocket ASL-B1	2/26	1628:30	Profile, 40-150 km
	Rocket A07.712-2	2/26	1748	Profile, 30-105 km
	Rocket CMSL-05	2/26	1915	Temperatures/winds, 30-65 km
	Rocket CMSL-06	2/27	0530	Temperatures/winds, 30-65 km
	Rocket CMSL-08	2/27	1545	Temperatures/winds, 30-65 km
	Satellite (TIROS N)	2/26	Sun synchronous	Temperature to ∽ 50 km
	Satellite (NIMBUS G)	2/26	Sun synchronous	Temperature to ∽ 90 km
	Satellite (DMSP)	2/26	Early morning and local noon	Temperature through stratosphere
Electric fields	Rocket 23.101 UE	2/26	1650:50	Vertical, 45-85 km
	Rocket 33.004 UE	2/26	1653:30	AC/DC vector, 100-195 km
	Rocket 23.009 UE	2/27	1200	Vertical, 30-85 km
Solar X-ray flux	Rocket 18.1020 UE	2/24	1652	2-8 Å
	Rocket ASL-B1	2/26	1628:30	1-10 Å
	Rocket 18.1021 UE	2/26	1652	2-8 Å
	Rocket 18.1022 UE	2/26	1654:10	2-8 Å
	Satellite (SOLRAD)	2/26	0000-1400	0.5-3 Å, 1-8 Å, 2-10 Å, 8-20 Å, 44-60 Å
	Satellite (GOES-3, GOES-4)	2/26	0000-1400	0.5-4 Å, 1-8 Å
Cosmic ray flux	Rocket ASL-B1	2/26	1628:30	E > 2 Mev

*Times are given in UT (subtract 6 hours from local time). Times for sounding rockets represent time of launch.

Since several types of measurements were made simultaneously (or closely corresponding) in time and space, direct intercomparison of data and/or measurement techniques should prove valuable. Table 4 gives a synopsis of the times and types of data where such intercomparisons may be made.

ASL SPONSORED EFFORTS

This section details the actual types of measurements made on the ASL sponsored rockets and offers a few preliminary comments on the results that were obtained. An account of the reduced and analyzed data will be given in subsequent reports.

Payload A_1

Rocket No: ASL-SE79A_1
Launch Vehicle: Nike-Orion
Principal Investigator: Profesor Kay Baker
Utah State University

Sponsor: US Army Atmospheric Sciences Laboratory

The principal objective was the measurement of density and altitude distribution of minor neutral species important to the neutral and ion chemistry of the middle atmosphere. Secondary objectives were the measurements of solar Lyman alpha flux and the density/distribution of free electrons.

Specific Instrumentation:

(1) UV lamp and photometer, ~1300 Å (atomic oxygen number density by resonance excitation of triplet 1302, 1304, 1306 A)

(2) 5577 Å photometer (atomic oxygen number density from emission of $O[^1S]$)

(3) 2150 Å photometer (resonance scattering of solar radiation by NO in the γ bands [~2050-2250 Å])

(4) 1.27μm radiometer (number density of $O_2[^1\Delta g]$)

(5) 1.595 and 1.944μm radiometers (number density of OH)

(6) 2925, 2975, 3025, and 3075 Å photometers (number density of O_3)

(7) 1216 Å ionization chamber (solar Lyman alpha flux)

(8) Impedance probe (electron number density)

TABLE 4. SIMULTANEOUS (OR CLOSELY CORRESPONDING) MEASUREMENTS

Date (Feb 79)	Approx Time (UT)	Measurements	Altitudes Range	Overlaps (approx)
24	1653-1705	Electron density (2 flights)	60-135	65-90
26	1629-1634	Electron density (2 flights)	65-135	65-135
26	1652-1705	Electron density (5 flights)	65-195	65-135 80-185
26	1652-1705	Positive ions (4 flights)	65-195	65-117 100-135
26	1654-1705	Negative ions (2 flights)	65-135	65-117
26	1652-1800+	Positive and negative conductivity (3 flights)	30-85	45-55
26	0330-0500	Positive and negative conductivity (2 flights)	30-77	30-65
27	1200-1330+	Positive and negative conductivity (2 flights)	30-85	30-77
24	1653-1659	Lyman alpha (2 flights)	60-135	65-90
26	1629-1635	Lyman alpha (2 flights)	65-155	65-135
26	1653-1703	Lyman alpha		
26	1630-1634 1653-1700	Particle precipitation and solar X-ray flux (3 flights)		

Preliminary Comments on Flight:

All instrumentation worked well except the NO measurement and output signals behaved as expected and fell within the design range. Coning of the payload was not excessive, a factor which will ease data reduction for the altitude sensitive measurements. Peak altitude of the payload was 139.75 km, slightly higher than predicted. Early data from the atomic oxygen detector (resonance lamp experiment) indicate structure and a peak density of the order $10^{12} cm^{-3}$ at an altitude of 98 km. Very high ionization background levels, particularly above 100 km, support other measurements indicating significant particle precipitation at the time of the eclipse. The high background is consistent with high atomic oxygen densities.

Payload B_1

Rocket No: ASL-SE79B_1*

Launch Vehicle: Nike-Orion

Principal Investigators: Professor Kay Baker
Utah State University

Dr. C. Russ Philbrick
Air Force Geophysics Laboratory

Dr. James McCrary
Physical Sciences Laboratory

Sponsor: US Army Atmospheric Sciences Laboratory

Principal objectives were measurements of the photon and particle flux responsible for ionization and dissociation of the atmosphere, electron density, and the density and temperature of the bulk neutral atmosphere.

Specific Instrumentation:

(1) Electron spectrometer for particle flux in energy bins 10-30 kev, 30-100 kev, 300-1000 kev and > 1000 kev

(2) Cosmic ray counter (energy > 2 Mev)

(3) Solar X-ray flux (1-10 Å)

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*Instrumented jointly by Utah State University (USU) and Air Force Geophysics Laboratory (AFGL).

(4) 1216 Å photometer (solar Lyman alpha flux)

(5) 2050 Å photometer (penetrating UV flux)

(6) Ten-inch falling sphere with triaxial piezoelectric accelerometer (atmospheric density and temperature)

(7) Impedance probe (electron number density)

Preliminary Comments on Flight:

The 10-in. falling sphere (AFGL) was ejected at approximately 66 km on the upleg of the rocket flight. Sphere apogee appeared to be greater than 155 km. Data quality appeared to be excellent and atmospheric density in the altitude range of 40-150 km is anticipated. The sphere is sensitive to drag of 10^{-7} g and can provide resolution of 100-150 m in density structure.

The energetic particle spectrometer observed exceptionally high fluxes for the latitude of Red Lake. At altitudes above 100 km, the analogue output covering the power density range of 10^{-4} to 3 x 10^{-1} ergs/(cm^2-sec-ster) for electrons less than 7.5 kev was at times saturated. Pulse summation counters should provide a very good measurement of energetic particle input.

The solar X-ray detector observed significant count rates to fairly low altitudes and the count rates were strongly spin modulated. The Lyman alpha detector provided very clear signals during the entire flight; the output increased to a maximum level at about 80 km and remained somewhat constant until payload descent to lower altitudes. The count rate from the cosmic ray detector increased from a background of approximately 1/sec to about 100/sec during flight.

All other instrumentation worked well.

Electron Density and Lyman Alpha Probes

Rocket No: CMSA-01, 01, 03, 04

Launch Vehicle: Super Arcas

Principal Investigator: Professor Kay Baker
Utah State University

Sponsor: US Army Atmospheric Sciences Laboratory

Objective was to provide electron density profiles and solar Lyman alpha flux under noneclipse conditions for background data and for calibration of ground-based measurements of lower ionosphere electron densities.

Specific Instrumentation:

(1) RF impedance probe (electron density profiles)

(2) DC probe (structure in electron density profiles)

(3) 1216 Å ionization chamber (solar Lyman alpha flux)

Preliminary Comments:

Good data were obtained from all instruments on all flights. Lyman alpha flux was observed to change by approximately four orders of magnitude in a smooth fashion. Because of other commitments, radar did not track CMSA-03 (day of the eclipse). However, the Lyman alpha measurement combined with similar measurements from other rockets should provide good altitude information as a function of time.

Gerdien Probes

Rocket No: CMSA-05, 06, 07, 08, 09

Launch Vehicle: Super Arcas

Principal Investigator: Professor Jack Mitchell*
University of Texas at El Paso

Sponsor: US Army Atmospheric Sciences Laboratory

Principal objective was to obtain altitude profiles of positive and negative ion conductivities, mobilities, and total ion densities and to compare these measurements with those obtained by other measurement techniques.

Specific Instrumentation:

Subsonic Gerdien condenser, parachute deployed (Starute decelerator) at rocket apogee

Preliminary Comments:

Good conductivity data were obtained for all payloads flown. Due to payload ejection malfunction, CMSA-06 (launched at 1653 UT on 26 February) will not provide conductivity data above 55 km. Measurements indicate that negative particle conductivity was smaller than the positive particle conductivity.

*Now at Pennsylvania State University, State College, PA.

Blunt Probe (Super Arcas)

Rocket No: CMSA-10

Launch Vehicle: Super Arcas

Principal Investigator: Dr. Jack Mitchell
University of Texas at El Paso

Sponsor: US Army Atmospheric Sciences Laboratory

Principal objective of this experiment was to obtain altitude profiles of positive and negative ion conductivities and to compare these with similar measurements made by Gerdien condensers.

Specific Instrumentation:

Blunt probe, parachute deployed (Starute decelerator) at rocket apogee

Preliminary Comments:

The instrumentation worked well and provided good charge conductivity data.

Meteorological Probes

Rocket No: CMSL-01, 02, 03, 04, 05, 06, 08

Launch Vehicle: Super Loki

Principal Investigator: Mr. Frank Schmidlin
NASA/Wallops Flight Center

Sponsors: NASA/Wallops Flight Center, US Air Force Air Weather Service, and US Army Atmospheric Sciences Laboratory

Objective was to measure atmospheric densities, temperatures, and winds in the altitude range of 30-65 km.

Specific Instrumentation:

(1) Bead thermistor, parachute deployed (Starute decelerator) at rocket apogee

(2) Tone ranging receiver ($\sim$400 MHz) to enable tracking and determination of winds

Preliminary Comments:

Good data were obtained in the altitude range of 18-65 km (some apogees may be slightly lower). Good data were obtained for one flight and very good data for five flights. The seventh flight (CMSL-01) launched on 19 February was not tracked by radar; therefore, wind data is not anticipated. It may be possible to reconstruct the descent trajectory from GMD tracking if there is a strong desire for this. Tie-in with radiosonde data at the lower altitudes will be possible.

Blunt Probes

Rocket No: CMSL-09, 10

Launch Vehicle: Super Loki

Principal Investigator: Mr. Robert Olsen
Atmospheric Sciences Laboratory

Sponsors: NASA/Wallops Flight Center, US Air Force Air Weather Service, and US Army Atmospheric Sciences Laboratory

Objectives were to measure positive and negative particle conductivities in the altitude interval of 30-65 km and to compare these with measurements made by other experimenters.

Specific Instrumentation:

Blunt probe, parachute deployed (Starute decelerator) at rocket apogee

Preliminary Comments:

Instrumentation worked well and data on positive and negative particle conductivities were obtained. A third blunt probe in this configuration was scheduled for launch 1200 hours UT on 27 February; however, instrumentation difficulties forced cancellation of flight and a meteorological payload, CMSL-08, was flown in its place (1545 UT on 27 February).

Partial Reflection Sounder

Partial Reflection Experiment

Principal Investigator: Mr. Robert Olsen
US Army Atmospheric Sciences Laboratory

Sponsor: US Army Atmospheric Sciences Laboratory

The partial reflection experiment is ground-based and had as its experimental objective the provision of D-region electron density profiles throughout the eclipse and for background (noneclipse) conditions. In operation, a HF (several megahertz) radar is used to transmit pulses of radiation vertically. Echoes backscattered from the D-region of the ionosphere are received and recorded as functions of pulse transit time. Circular polarization of the transmitted radiation is utilized, and pulses of both the right- and left-hand polarization are employed. Because of the earth's magnetic field, the index of refraction of the ionosphere is different for the two polarization modes. The relative intensities of the waves partially reflected from a given altitude within the ionosphere contain information concerning the electron density at that altitude. This partial reflection technique can be used to measure the density of free electrons in the ionosphere as a function of altitude from 60 to 100 km. A single frequency of 2.666666 MHz was employed. The partial reflection experiment was located in Balmertown, Ontario, and operated for a period of several days before, during, and following the total solar eclipse.

Preliminary Comments:

The instrumentation worked well after some early equipment difficulties. For 30 minutes, centered approximately on totality at Balmertown, soundings were taken at 1-minute intervals. Throughout this period, a broad layer of relatively high electron densities was found between 73 and 83 km. Peak densities were of the order 500-600 electrons cm^{-3}. Such a layer is indicative of a particle precipitation event. Forty-eight hours earlier, coinciding with the launching of rocket 18.1020 UE, a similar layer, with peak densities of approximately 100 cm^{-3}, was found between 60 and 70 km. From these records it would appear that the energy spectrum for the precipitating particles was considerably harder (i.e., contained more higher energy particles) on 24 February than on the day of the eclipse. On both days the total flux would appear to be high and the spectrum quite hard.

SUMMARY AND CONCLUSIONS

The 1979 Solar Eclipse Program was a cooperative, multiagency effort which successfully measured the properties of the lower ionosphere and middle atmosphere during the 26 February 1979 solar eclipse. The program met with outstanding success in that all but two of the approximately 80 measurements yielded useful results. Several types of measurements were made simultaneously, often with different measurement techniques, which will enable one to remove the ambiguities often inherent in a single measurement and at the same time permit useful comparison and cross correlation of methods. The complete sets of data from this program may well prove to be the best set of coordinated measurements in the D and E regions in recent years.

Preliminary analyses of data show clearly that particle precipitation, principally electrons, was the dominant source of ionization in the middle atmosphere during the eclipse period. Thus, much useful data on the aurorally disturbed daytime atmosphere has been collected. Attention is necessary in separating the explicitly solar eclipse related effects from the electron precipitation induced effects when analyzing the data.

REFERENCES

1. Heaps, M. G., R. O. Olsen, and W. W. Berning, 1972, Solar Eclipse 1979: Atmospheric Sciences Laboratory Program Overview, ASL-TR-0026, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM.

2. Heaps, M. G., 1978, The 1979 Solar Eclipse and Validation of D-Region Models, ASL-TR-0002, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM.

3. Heaps, M. G., F. E. Niles, and R. D. Sears, 1978, Modeling the Ion Chemistry of the D-Region: A Case Study Based on the 1966 Total Solar Eclipse, ASL-TR-0015, US Army Atmospheric Sciences Laboratory, White Sands Missile Range, NM.

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